OCR
RECOGNISING ACHIEVEMENT

Friday 18 January 2013 – Morning

A2 GCE APPLIED SCIENCE

G635/01 Working Waves

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour 30 minutes

MODIFIED LANGUAGE

1506778597

G6350 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 An African wind instrument called a vuvuzela became well known when it was used by fans during the 2010 World Cup in South Africa.

It is a plastic pipe. The pipe can vary in length. It produces sound in the same way as a pipe that is open at both ends.

(a) Fig. 1.1 shows a pipe that is open at both ends. Air in the pipe is oscillating at the fundamental frequency. On the diagram, mark:

- the position of the node(s) with the letter '**N**'
- the position of the antinode(s) with the letter '**A**'.

Fig. 1.1

[2]

(b) State the fraction of a wavelength between a node and the nearest antinode.

answer = ... wavelength **[1]**

(c) Use your answers from parts **(a)** and **(b)** to find the fraction of a wavelength represented by the length of the pipe in Fig. 1.1.

answer = ... wavelength **[1]**

(d) Use your answer from part **(c)** to find the approximate wavelength of the fundamental note produced by a vuvuzela of length 65 cm.

wavelength = ... unit ..... **[2]**

(e) A student investigating the vuvuzela also conducts an experiment using a different pipe. This pipe produces a note at 310 Hz when the wavelength is 111 cm.
Calculate the speed of sound in air in $m\,s^{-1}$ in this pipe.

speed = ... $m\,s^{-1}$ **[3]**

(f) In practice, both the amplitude and frequency of the sound produced by vuvuzelas varies.

(i) State the effect of an increase in **amplitude** on the sound heard.

.....

..... **[1]**

(ii) State what is meant by the term *amplitude of a sound wave* in terms of the movement of the air.

.....

.....

.....

..... **[2]**

(iii) State the effect of an increase in **frequency** on the sound heard.

.....

..... **[1]**

(iv) State what is meant by the term *frequency of a sound wave* in terms of the movement of the air.

.....

..... **[1]**

(g) Fig. 1.2 shows the direction of propagation of a sound wave (the direction in which the sound is travelling). Four other directions are labelled **a**, **b**, **c** and **d**. One of these four directions is the direction of oscillation of molecules in the air caused by the sound.

Draw a circle around the letter indicating the direction of oscillation.

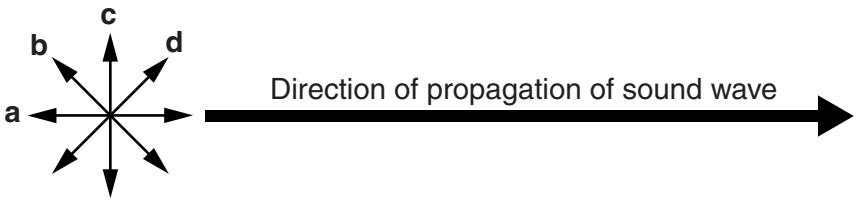

Fig. 1.2

[1]

[Total: 15]

2 Various forms of lighting are used at modern sports venues.

Light consists of oscillations in electric and magnetic fields.

(a) Fig. 2.1 shows the direction of propagation of a light wave (the direction in which the light is travelling). Four other directions are labelled **a**, **b**, **c** and **d**. One of these four directions is the direction of oscillation in the electric field associated with the light.

Draw a circle around the letter indicating the direction of oscillation in the electric field.

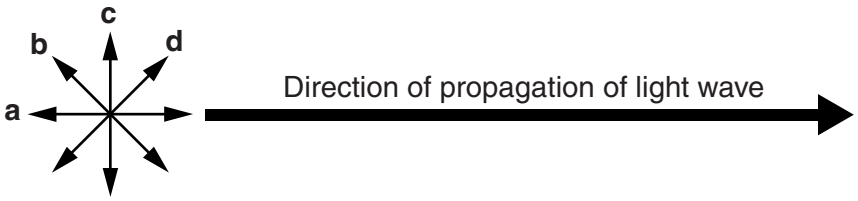

Fig. 2.1

[1]

(b) Describe the direction of oscillation in the magnetic field associated with this electric field.

.....

..... **[1]**

(c) Light is shone onto a white screen.

(i) The **amplitude** of the light waves is increased.

Describe the effect of this change on the appearance of the screen.

.....

..... **[1]**

(ii) The **frequency** of light falling on the screen is shifted towards the high frequency end of the visible spectrum.

Describe the effect of this change on the appearance of the screen.

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..... **[2]**

[Total: 5]

3 Digital infrared thermal imaging (DITI) is used by doctors for diagnosis. DITI can only respond to the temperature of the skin, but this will often give doctors clues about the state of the tissue underneath.

(a) Describe how skin at different temperatures will appear in the image formed on the screen.

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..... **[1]**

(b) DITI is sometimes used to detect breast cancer. However, X-ray examination is still commonly used for breast cancer screening.
Suggest one advantage of DITI compared to X-ray examination.

.....

..... **[1]**

(c) The thermal resolution of DITI instruments used for medical applications is typically 0.1 °C or 0.01 °C.

(i) State what is meant by the term *thermal resolution*.

.....

..... **[1]**

(ii) Suggest why the thermal resolution needed for medical applications is different from the thermal resolution needed for thermal imaging cameras used by fire fighters.

.....

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.....

..... **[2]**

(d) Before Jo is examined using DITI, a nurse explains how the skin temperature can give information about the tissue below the skin. The nurse uses the example of turning red with embarrassment as a response to an emotional reaction.

(i) If a thermal imaging camera was used to form an image of someone turning red with embarrassment, it would not be sensitive to the visible light colour.

Would you expect a thermal image to show if a person is embarrassed?

Explain your answer.

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.....

.....

..... **[2]**

(ii) Jo thinks that the nurse's explanation is a good one but her friend disagrees.

Give possible reasons for **both** of their opinions.

The nurse's explanation **is** a good one because:

.....

.....

The nurse's explanation **is not** a good one because:

.....

.....

[2]

[Total: 9]

4 Mary is studying science and has seen graphs of the intensity spectrum of radiation emitted by black bodies.

(a) State what is meant by a *perfect black body*.

.....

..... **[1]**

(b) Fig. 4.1 shows graphs of the intensity spectra of radiation emitted by objects at different temperatures.

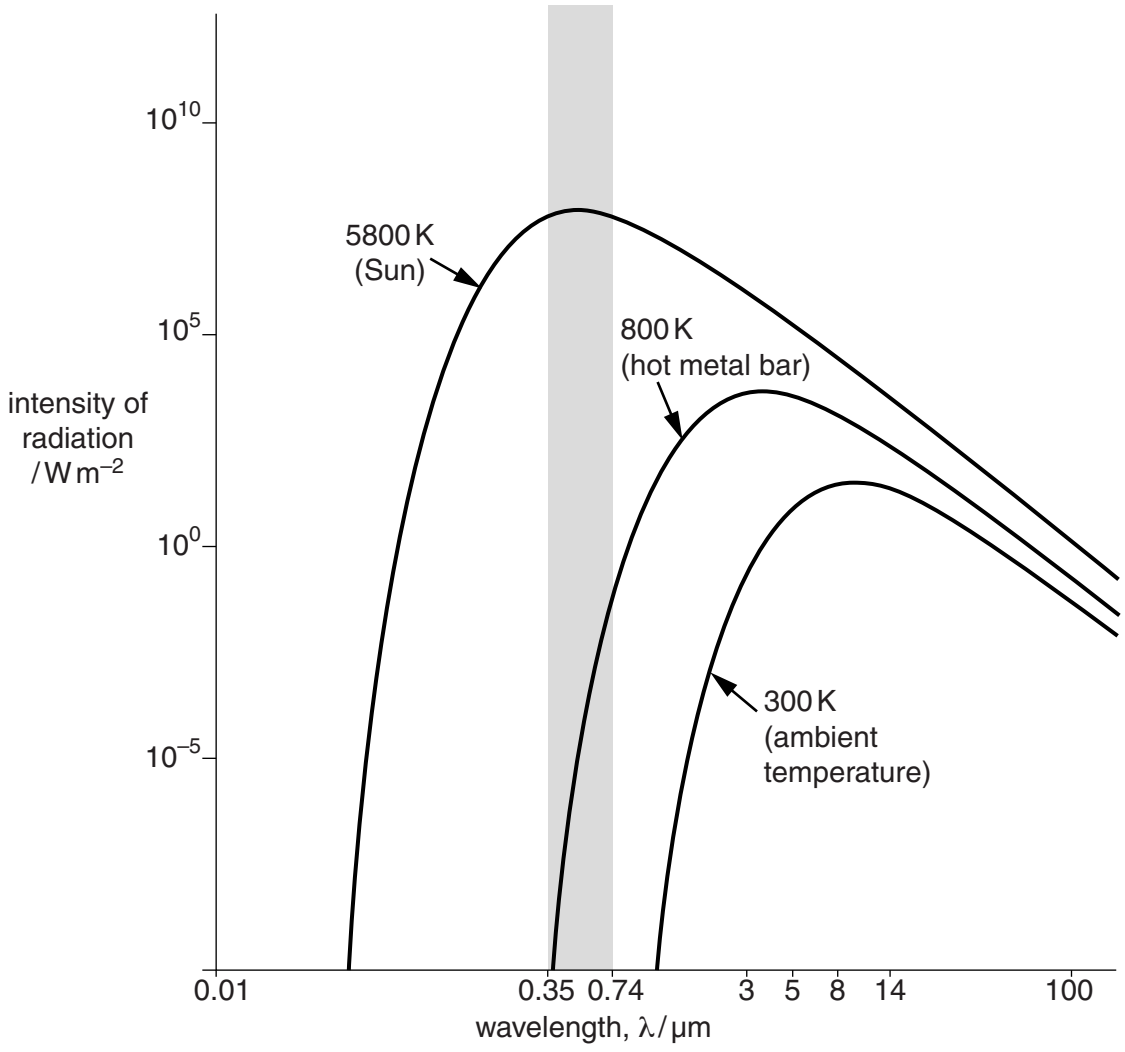

Fig. 4.1

How might Mary use Fig. 4.1 to explain the different **visible** light colours emitted by objects at various temperatures?

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..... **[6]**

[Total: 7]

5 In the optics section of a science museum, one area is devoted to applications of total internal reflection (TIR).

(a) Light is travelling within a glass block and reaches a glass-air interface. Total internal reflection occurs.

Explain what is meant by *total internal reflection*. You may use a diagram to help your explanation.

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..... **[3]**

(b) Total internal reflection is used in optical fibres. The first experiments were conducted in the 19th century. By the early 20th century, TIR was being used for illumination in dentistry. One of the exhibits in the museum also shows more recent developments including:

- a multimode step-index fibre
- a graded index fibre
- a monomode fibre.

(i) Students visiting the museum are given a worksheet about monomode fibres and multimode step-index fibres.

Complete the worksheet.

Science Museum Worksheet

1. Compare the core diameters of the monomode and multimode step-index fibres, giving typical values.

.....

.....

.....

..... **[2]**

2. Compare the number of possible paths along the two types of fibre.

.....

..... **[1]**

3. Comment on:

the path lengths for rays in multimode step-index fibres

.....

..... **[1]**

the effect path lengths have on the time at which a signal arrives at the far end of a fibre

.....

..... **[1]**

the effect signal arrival times have on signal quality.

.....

..... **[1]**

(ii) The museum needs an information card put beside an exhibit.

Write an explanation of the ways in which graded index fibres are better than multimode step-index fibres. Include a diagram.

Why graded index fibres are better than multimode step-index fibres.

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[6]

(c) Binoculars are used to see distant objects clearly. The museum has a display to show how total internal reflection is used in binoculars.

The light passing through binoculars is reflected by total internal reflection inside triangular glass prisms.

Fig. 5.1 shows this taking place.

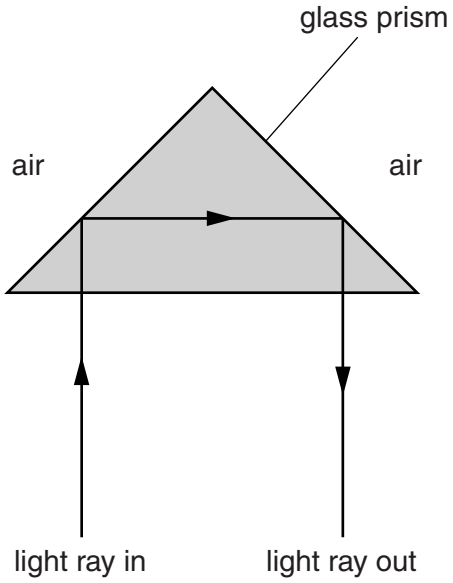

Fig. 5.1

(i) On Fig. 5.1, indicate by a letter '**T**' a point at which total internal reflection takes place. **[1]**

(ii) Fig. 5.2 shows two other rays labelled **A** and **B** entering the prism. Suggest and explain whether you would expect each of these rays to undergo total internal reflection at face **PQ** of the prism.

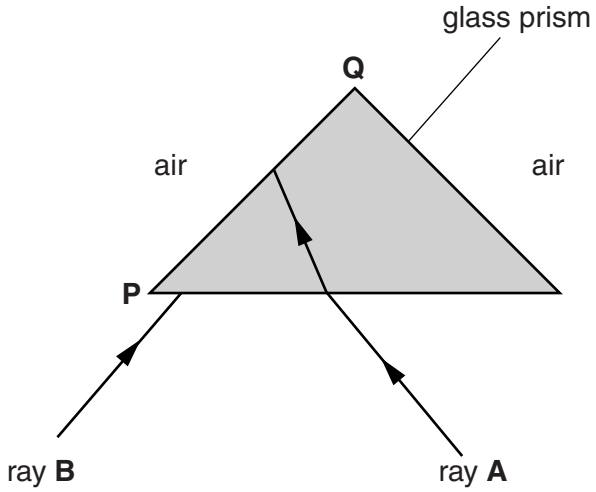

Fig. 5.2

ray **A** .....

.....

ray **B** .....

.....

[3]

[Total: 19]

6 The extract below is taken from a student's essay about mobile phones. Complete the blank spaces using word(s) or number ranges from the list below.

Items from the list may be used once, more than once or not at all.

0.1–0.5	**frequencies**
0.5–20	**full duplex**
20–50	**half duplex**
50–100	**multiplexing**
base station	**obstructions**
many users	**satellite**
down-link	**up-link**

The signal from your mobile phone travels as a radio signal to a …… . This process is called …… . The reverse process, when the radio signal travels to your mobile phone, is called …… .

Two developments in technology have made it possible for millions of people to use mobile communications. Firstly, the country is divided into cells each of approximate radius …… miles. Some cells are larger than others. Cells tend to be smaller if there are …… , or …… .

The second technological development makes it possible for many users to share the same frequency in the same cell. This is called …… . Adjacent cells always use different …… .

Unlike CB radios, mobile phones work on a system that makes it possible for both users to speak at the same time. This system is called …… . It requires the allocation of two separate …… .

[10]

[Total: 10]

7 A music collector has a collection of old tapes and vinyl records such as those shown in Figs. 7.1 and 7.2. He reads an advertisement for a device which can convert analogue recordings like these to the digital system used by MP3 players.

Fig. 7.1

Fig. 7.2

(a) Describe the features that distinguish analogue and digital systems.

digital .....

.....

analogue .....

.....

[4]

(b) Most digital meters display readings to the base ten.

(i) State the number base that is used for recorded music and the internal workings of computers.

..... **[1]**

(ii) State what name is given to this type of digital coding.

..... **[1]**

(c) Describe how Pulse Code Modulation (PCM) can be used to convert music to digital signals. You may illustrate your answer with a diagram.

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..... **[4]**

(d) Peter is a fan of 1960s pop music. He has recently learnt to surf the internet, which did not exist when he was young. His new broadband connection allows him to download his favourite music faster than his old dial-up connection.

(i) Explain how broadband provides faster downloads.

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..... **[2]**

(ii) Another advantage of broadband compared to dial-up connections is that it frees up Peter's landline so that his wife can use the telephone while he is online.

Explain how this is possible.

.....

..... **[1]**

[Total: 13]

8 In recent years digital X-ray machines have replaced X-ray sensitive film in many medical applications.

(a) (i) Explain why image-intensifying screens are used with X-ray film.

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..... **[2]**

(ii) State where image-intensifying screens are placed relative to the film.

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..... **[2]**

(iii) Explain what the screen does to achieve its purpose and how this affects the film.

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..... **[2]**

(iv) State **one** disadvantage of using an image-intensifying screen.

..... **[1]**

(b) (i) In digital X-ray cameras, the X-rays that have passed through the patient first meet a phosphorescent material such as caesium iodide.

State what is emitted by this material.

.....

..... **[1]**

(ii) The next stage is an array of photodiodes.

State the function of the photodiodes.

.....

..... **[1]**

(iii) State what occurs in the final stage in a digital X-ray camera.

.....

..... **[1]**

(c) A manufacturer tests a new X-ray machine by using it to form images from X-rays that have been passed through four different materials: **air**, a **'barium meal'** contrast medium, **bone** and **fat**.

Complete the table below to indicate how much each of these materials absorbs X-rays compared to the others.

Write the name of the most absorbing material opposite the number 1.
Write the name of the next most absorbing material opposite the number 2 etc.

air
'barium meal'
bone
fat

Absorbing properties (1 = most absorbing 4 = least absorbing)	**Material**
1	
2	
3	
4	

[2]

[Total: 12]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margins.